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Gas Journal

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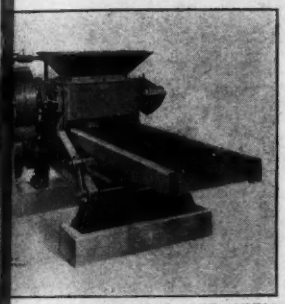
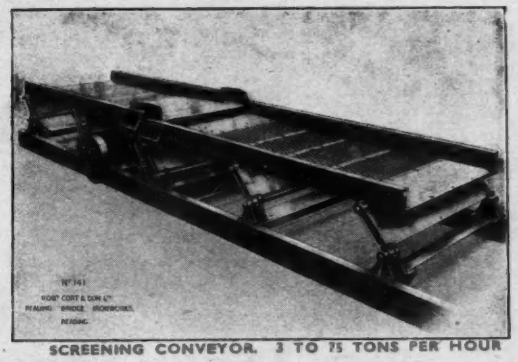
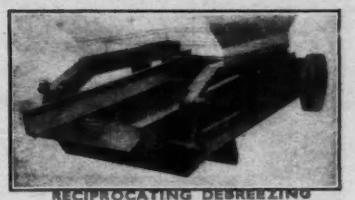


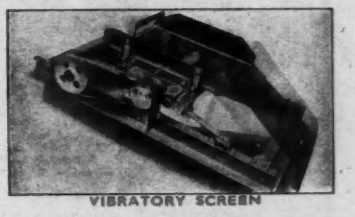
OKE CUTTING MACHINE WITH RECIPROCATING SCREEN



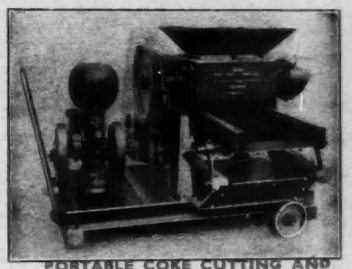
SCREENING CONVEYOR. 3 TO 75 TONS PER HOUR



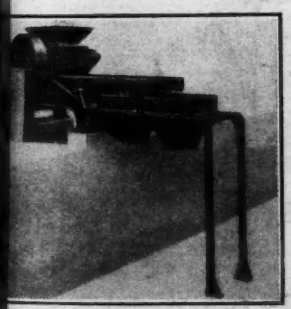
RECIPROCATING DEBREEZING SCREEN



VIBRATORY SCREEN



PORTABLE COKE CUTTING AND SCREENING UNIT



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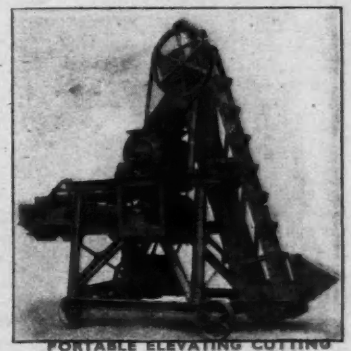

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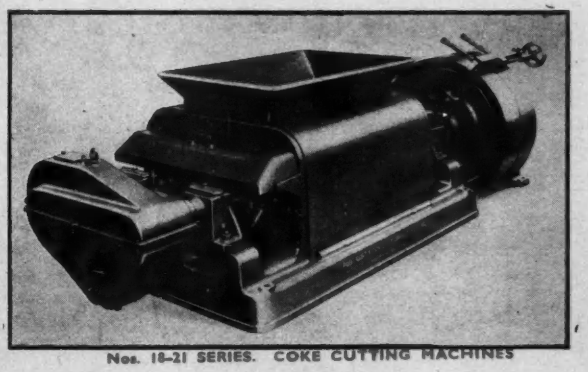

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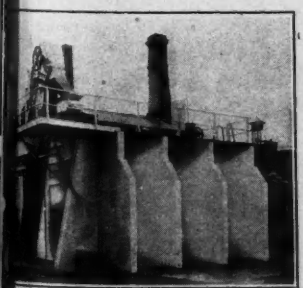

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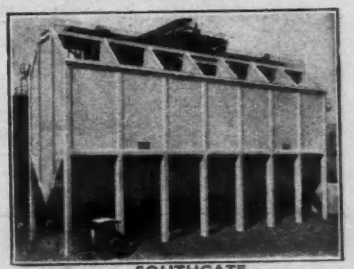

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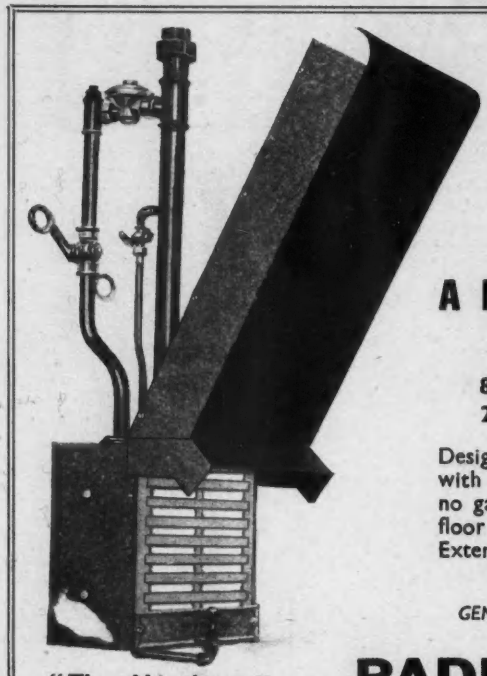

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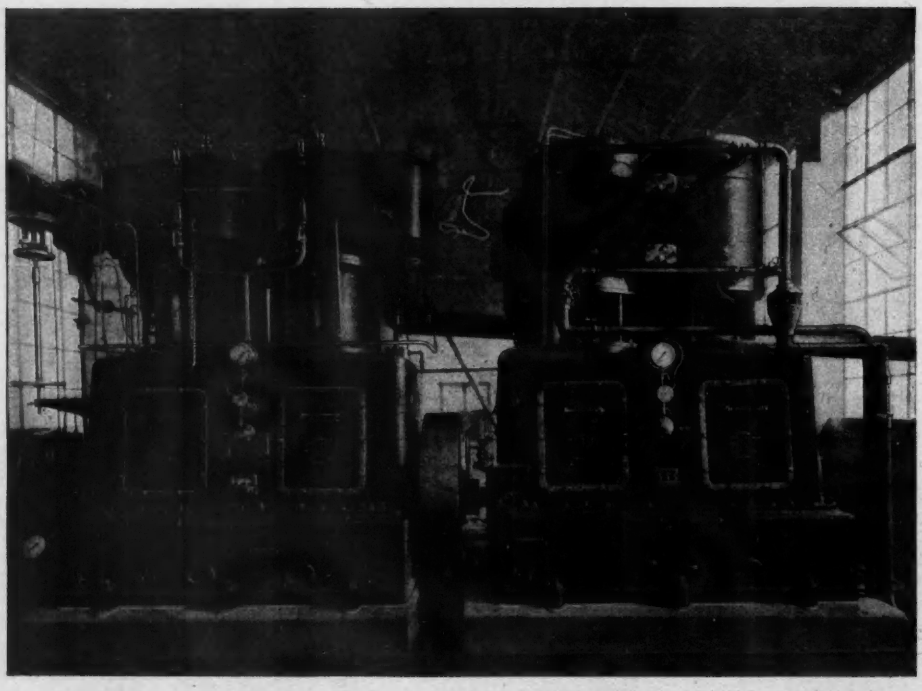

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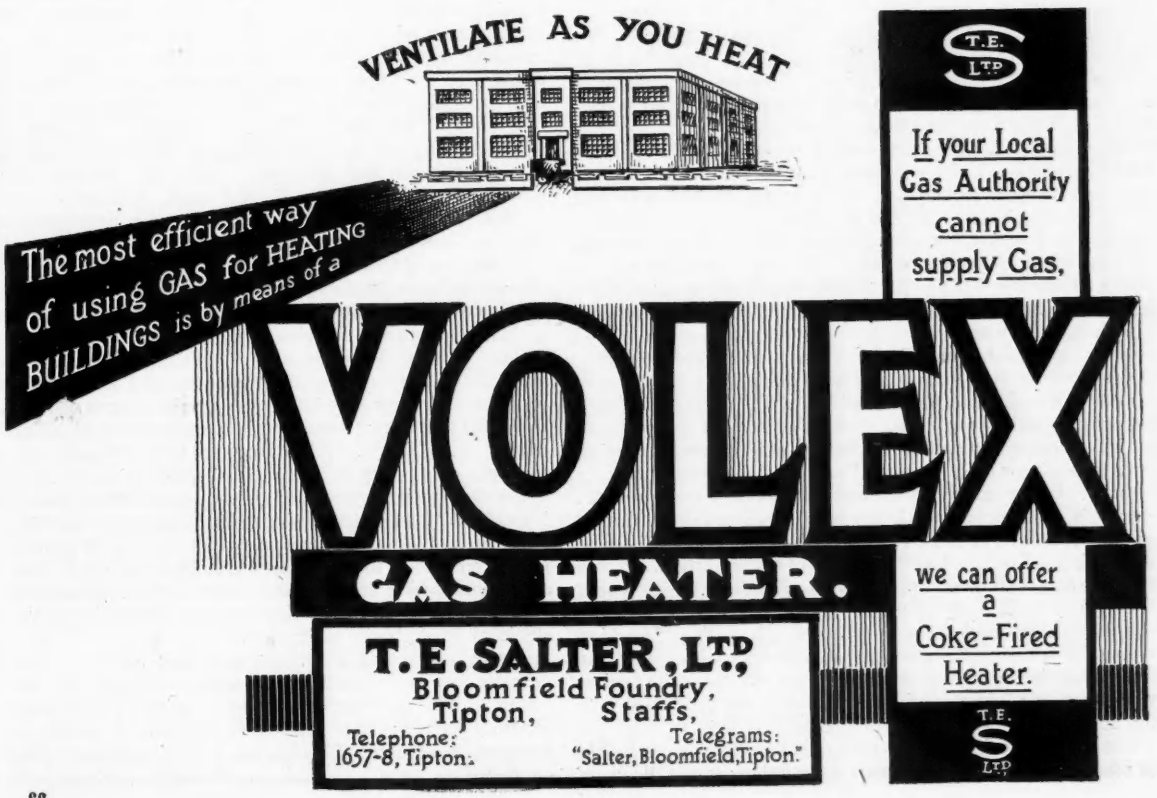
Communications addressed to Bolt Court have to be forwarded, and this causes delay.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GAS JOURNAL, DEC. 1, 1943

VOL. 242 95th YEAR No. 4202

EDITORIAL NOTES

POST MORTEM

WHAT happens to coal when it is carbonized in continuous vertical retorts with all sorts of factors at work? We cannot travel down with the coal inside the retort; even our enthusiasm would be quelled by discomfort, and the notions we should gather on the way would go up in smoke and would never grace the pages of any transactions. If rather less heroic than this fantastic conception, at least the investigatory measures taken by Dr. Haffner and Dr. Weston, of the Gas Light and Coke Company, and described by them last Friday to the Eastern Section of the Southern Association of Gas Engineers and Managers, were at the same time original and practical, and they give a pointer to others to follow their lead on similar lines. The meeting, by the way, was an outstanding success as a novel and model demonstration of carbonization in a solid form. Highly technical information was interpreted, with the aid of a model and no little understanding of the subject, with what seemed to us brilliant clarity, and in point of fact the meeting had to be brought to a close, not through lack of discussion, but for want of time. New ideas and new methods were presented, and the meeting was stimulating and encouraging as affording positive proof of technical skill and scientific approach which will stand the Industry in fine stead whatever political upheavals the future may see and whatever the hues of our ties.

In due course we shall deal faithfully and fully with the Paper presented. Our present note is merely in the nature of a "trailer," merely to excite interest in "things to come." The technique employed in the investigation was to "freeze" a set of retorts, under carbonizing conditions, at the end of their useful life, bravely sousing them with water at a rate of 10,000 gallons an hour, temporarily forgetting, in the quest for truth, the fuel expenditure index. For many years now the Gas Light technical staff has been interested in studies of continuous vertical retorts, particularly when carbonizing Durham run-of-mine coal, and the Authors pointed to the fact that the properties of such coal are not so favourable for smooth travel as those of nut coal or coals from some other fields. But any developments of design or operation to overcome these imperfections will doubtless be applicable to the carbonization of more smoothly travelling coal, where the difficulties occur to a minor degree or may even not be recognized. In the art of carbonization in vertical retorts there has accumulated throughout the Industry a wealth of experience and operational skill. The basis of this, however, is mainly empirical. Designers have, of course, made rapid progress since the introduction of continuous vertical retorts, but knowledge does not "stay put," and many questions remain to be answered if progress is to continue at the same rate. And this development work has been handicapped by lack of visual evidence of the nature of the charge, which is clearly to be seen in intermittent systems at the end of carbonization. It was felt that a new stimulus to process technique and design would follow from a discovery of the nature and structure of the inner charge of the retort while working; and shock cooling of working retorts by spraying the combustion chambers with water was undertaken in an attempt to preserve the charge in its typical working state. The Paper under discussion was concerned with the post-mortem examination of "frozen" charges.

The facts and evidence collected are not necessarily applicable to other types of retort. It stands out a long way that the value of the data gathered together would be more than doubled by repeating the same experiment upon another installation of retorts. Naturally this can be done only on retorts which are due for demolition, but it is good to know that as the opportunities arise the work will be extended. And here we note with lively satisfaction that should other undertakings have retort settings about to be demolished and would like to quench one or two retorts to add to the pool of knowledge, the Gas Light and Coke Company would be happy to co-operate. Until the evidence is considerably widened the pitfalls of premature conclusions are to be avoided. The Paper is concerned with marshalling the first series of facts. There are inferences to be drawn. Our point here is that a technique has been developed which with further improvements could be applied to the examination of the structure of the charge in other installations of continuous vertical retorts. The correlation of all the evidence to be collected would, we think, lead to a more fundamental approach to retort design and operation.

DISTRICT HEATING

IN our issue of August 4 we published an article by Mr. J. E. Davis on the subject of district heating. The article appealed to us very much, in that it brought to bear a sense of proportion, a reasonable technical balance, on the whole matter, which is being discussed all too airily in many non-technical quarters in connexion with the planning of future homes offering more amenities than in the past. There is evidence of over-optimism concerning the application of district heating, and insufficient appreciation of the complex problems involved and the capital cost entailed. As we said in the "JOURNAL" of August 11, steam costs money, and the application of "waste" steam costs money—a good deal of money when one considers district heating on anything but a limited scale. Utilization even of "waste" steam is a more formidable economic proposition than some non-technical enthusiasts imagine.

In the article to which we have referred, the Author, having pointed out that the distribution of heat in steam is much more costly than the distribution of the equivalent amount of heat as gas, put forward the view that for a residential district of separate houses the transmission losses might well amount to 40 or 50%; and he added that with coal at 25s. a ton the cost of steam to a consumer in a densely built-up area is not likely to be less that 4d. a therm, and in a residential area is likely to exceed 6d. a therm. When we turn to the question of the economy of securing electric energy before delivering the steam to the distribution system, it has been suggested that the steam, if employed for district heating, would obviously be cheap. In point of fact, however, from electricity generating stations the heat is rejected at too low a temperature to be of any value for a district heating scheme, and increasing the temperature of reject from a generating station implies decrease in the thermal efficiency of electricity generation.

America is largely quoted as providing an example in the development of district heating which we should follow in this country. But in America experience has been marked by a tendency for electricity generation and district heating to be operated as separate undertakings, and for schemes originally combined to become separated. Actually we return to the

subject in view of the comments we have received from the contributor of a regular feature in the "GAS SALESMAN," "American Notes and Notions." What he has to say will be found in the current issue; we will merely epitomize his remarks here. The American Gas Industry, he states, does not regard district heating as a serious hindrance to the development of gas sales for house heating, and he cites his own experience when he was associated with a rapidly expanding combination gas and electricity undertaking, including district heating systems. The necessary rates to make the district schemes profitable were far too high to meet competition. In fact, it became necessary, from economic considerations, to persuade as many district heating consumers to change over to gas heating. In his own words: "We could have afforded to give them the gas heating equipment, completely installed, but we didn't." About 15 years ago there were seven such systems in his area. All but two are inactive to-day—and those two are now independently owned. In New York and Philadelphia separate companies operate, but they confine their operations to the business sections, heating skyscrapers and warehouses, and in no way take a load yet attainable by the Gas Industry.

The Post-War Home

We have already referred to the setting-up by the B.C.G.A. of a special Domestic Heat Services Committee to examine and co-ordinate all the existing work on the subject, so that a clear picture can be obtained of what is needed to transform housework from a burden to a pleasure. The Committee's researches are covering many aspects of domestic work, including a special study of a woman's movements in the kitchen and of efficient ventilation. As we mentioned in the "JOURNAL" of Sept. 15 last, Miss Jane B. Drew, F.R.I.B.A., has been appointed to act as Consultant to the Committee. She is going to America shortly to see the experimental work in progress there. When her researches are complete it is the intention of the Committee to make its subsequent findings available to all, so that housewives everywhere may benefit by this knowledge as well as those concerned with providing the structure and amenities of post-war homes. The Ministry of Works will also be kept informed of the trend of this work, of which it is fully cognizant.

Personal

Dr. H. S. HOULDSWORTH, K.C., Fuel Controller for the North-Eastern Region, has been appointed Controller-General of the Ministry of Fuel and Power following upon the retirement of Lord Hyndley from that post. Dr. Houldsworth will take up his new duties at the New Year.

1943 "Journal" Directory

Page 133. INSTITUTION OF GAS ENGINEERS. A. G. Higgins, *Asst. S., vice* W. E. le B. Diamond.

Diary

Dec. 2.—Industrial Gas Centres Committee: Gas Industry House, 9.30 a.m.

Dec. 8.—Institute of Fuel: Connaught Rooms, Kingsway, W.C. 2, 2.30 p.m.

Dec. 11.—Scottish Junior Gas Association (Eastern District): Meeting with Western District, Glasgow. Address by Colonel C. M. Croft.

Dec. 14.—Federation of Gas Employers: Central Committee, Gas Industry House, 11.45 a.m.

Dec. 14.—National Gas Council: Central Executive Board, Gas Industry House, 2.15 p.m.

Dec. 15.—British Gas Federation: Council, 3 p.m., followed by Annual General Meeting, Gas Industry House.

Dec. 15.—London and Southern District Junior Gas Association: Meeting at Gas Industry House. Paper by Mr. L. Muir Wilson.

Dec. 15.—National Federation of Gas Coke Associations: General Committee, Gas Industry House, 10 a.m.

Dec. 20.—London and Counties Coke Association: Finance Committee, 11 a.m.; Executive Committee, 11.30 a.m.; Central Committee, 1.30 p.m., Gas Industry House.

Letters to the Editor

Domestic Gas Appliances

DEAR SIR,—Reading the Editorial in your Nov. 17 issue upon domestic appliances, it occurs to me that the criticism you have put forward in your first paragraph of Mr. Forshaw's outspoken opinion trips over the word "produces."

If Mr. Forshaw had stated that makers with *plans or designs* for new and improved appliances ready immediately after the war would "be suspect as to the totality of their efforts during the war," he would, in my opinion, have merited your criticism. But he used the word "produces" with, I am sure, full knowledge of the position. It is no secret, as your columns have already shown, that the Gas Stove Makers' Panel, which is composed of the largest and oldest established of the British makers, has put in, notwithstanding the enormous demands of war work placed upon them, a good deal of useful work upon this subject of post-war planning for a long time past, but as Mr. Forshaw has pointed out, and the discussion of his paper emphasizes, makers' vital commitments now are a bar to the best hopes of "*producing* the new goods *immediately* after the war."

The further points you refer to about (1) non-aerated flames and (2) water heaters will, I am sure, receive Mr. Forshaw's attention upon his return to London, and I shall be interested to see his reply. The former case is obviously one where the Industry will be guided by the findings of its experts. Good things cannot be kept down very long, once these are proved. In the second case I think a further reading of Mr. Forshaw's remarks should make it very plain that he advocates a water heater to fit each job and not, as at least one large maker advises, one type of water heater for every kind of job. Strange as it seems, you actually at the end of your criticism repeat, as your own, the views Mr. Forshaw gives in his Paper on this point.

48, *Grosvenor Gardens*, Yours faithfully,
London, S.W. 1. H. F. POTTER.
Nov. 25, 1943.

The B.G.F. Planning Report

DEAR SIR,—The B.G.F. Report on the Planning of the Gas Industry gives useful statistical data. It fails to tackle the fundamental technical and economic problems facing the Industry. It seeks to base the future on the dismal past. It has no dynamic force, no vision, no invigorating call to action. The arguments against a nationalized social service for fuel are puerile, surely not intended as serious arguments addressed to thinking people.

The measure of failure of the Gas Industry is that after one hundred years of "progress," forty million tons of bituminous coal are consumed per annum in open fires. The Report seeks to continue this rate of "progress."

Private enterprise in the Gas Industry seeks protection from "unfair" competition (deemed unfair because the opponent has been slicker and more vigorous in every way), and at the same time extols the joys and benefits of competition. This is too bad! Private enterprise cannot have it both ways.

The Report offers us a National Fuel Advisory Council to plan the co-ordination of fuel resources and utilization, and a National Gas Council to be counsellor and guide. It has not given these bodies a motto; I suggest *Ex Nihilo, nihil fit*, for, without legal sanctions, the work of these bodies will be in vain.

The function of the carbonizing industry is to provide gaseous and solid refined fuels suitable for all the countless purposes of a modern society—a true social service of fuel with the ultimate aim of processing every ton of bituminous coal raised from the pit. This job of work is just too big and involved for private enterprise to tackle, since it is based on competitive prices and profits. The job can only be done by national ownership and planned control, which can solve or override the problems involved; only thus can a true social service of fuel be built.

The acid test of any plan or policy, industrial or social, is not "Will it pay?" or "Will it enrich this class or the other class?" but "Will it make better men and women?"

4, *Broadway*, Yours faithfully,
Partington, via *Urmston*, JOHN ALBINSON.
Near Manchester.
Nov. 25, 1943.

Comparative Distribution of Gas and Electricity in Rural Areas

DEAR SIR,—Are there any available data on this (for gas) in rural areas? Having ventured the suggestion that more cottages have gas in rural areas than electricity, the Author of an article in *The Spectator*, p. 403, Oct. 29, on "Cottager's Light," flatly contradicts my suggestion, and quotes only an estimate of the British Electrical Development Association, Section 65, Cmd. 6378, Lord Justice Scott's Report: "In 1939 about one-third of all dwellings in rural district areas were not yet electrified." I note this section states that "under 30,000 agricultural holdings are served with electricity out of a total of 365,972 in 1938."

I have deplored the absence from the Electricity Commission's Form (El.C. 25) for Technical and Financial (Annual) Returns of

any item which can give evidence of the implementing of obligations to supply where there are homes.

Of 626 authorized electricity suppliers, only 386 return to *Garcke's Manual* the number of premises in their monopoly areas. Of these only 60 claim to supply as many as 90% of premises: 82 claim to supply from 50 to 89%; and 239 claim to supply from 10 to 49%.

Lt.-Col. C. Waley Cohen states in *The Spectator*, p. 505, Nov. 26, that the information quoted above *is* complete. As a matter of fact it is quite indefinite, and we need accurate information on what basis E. D. A. claims that two-thirds of all dwellings in rural district areas were electrified in 1939.

I am desirous of securing complete, authoritative comparative figures for gas and for electricity in rural and in urban areas, having analyzed the available data in the 386 authorized areas from *Garcke's Manual*.

11, *Dence Park*, *Herne Bay*.
Nov. 26, 1943.

Yours faithfully,
THEODORE STEVENS.

In Praise of Superannuation

DEAR SIR,—We have recently had an example of practical appreciation of the benefits of superannuation.

An *ex* Chief Cashier of this Company, who retired on pension on Dec. 31, 1931, died in October of this year, and having no dependents bequeathed by Will the sum of £1,000 to the Trustees of the Superannuation Fund for the benefit of the members.

Preston Gas Company, *Nov.* 19, 1943.

Yours faithfully,
S. G. DEAVIN,
Secretary.

USE OF COKE OVEN GAS*

By T. T. TARN, Darlington

THE question of purchasing supplies of coke oven gas has for a long period caused much discussion in the Industry. In the last few years considerable additions have been made to the number of coke ovens in the North-East area, and more gas undertakings have taken up the utilization of surplus coke oven gas, either entirely, or as an addition to the gas manufactured by them. These undertakings have eliminated many troubles as regards the supply of coal, but, unfortunately, unusual troubles are met with on coke ovens, due to wartime conditions, such as the suspension of the charging and discharging of ovens during an "alert," and the result of this stoppage is passed on to the undertakings who are supplied with the surplus gas. A stoppage of any duration causes a reduced output of gas of varying quality, with a consequent reduction in calorific values.

The taking of supplies of coke oven gas by undertakings must largely depend on the proximity of the ovens to the gas-works concerned, after considering the possibility of breakdown at the ovens. The question of the price asked for the gas is also very important, and particularly at the present time, whether the interests of coal conservation are safeguarded.

Just over eight years ago the Darlington Corporation made a contract with coke oven owners for a supply of gas. The coke oven plant was built and erected by the Woodall-Duckham vertical retort and Oven Construction Co., Ltd., and comprises 59 Woodall-Duckham Becker ovens. The ovens are arranged in one battery, with the coal bunker at one end and the chimney stack at the other. Before actually taking supplies of coke oven gas in 1937, a carburetted water gas plant was erected by Messrs. Humphreys & Glasgow, Ltd., as a standby, and this can be put into operation at short notice. The plant was installed for hand operation, but, owing to labour shortage, it was considered desirable to convert to mechanical operation, and the makers have fitted their latest type of mechanical valve operation, so that now the only part of the process involving any great degree of laborious work is the clinkering and coke handling.

The gas is compressed to between 20 and 30 lb. per sq.in. at the coke ovens, according to the quantity being delivered through the 12-in. internal diameter main, which is approximately 16 miles long, and consists of Stanton spun iron pipes, with Stanton-Wilson flexible joints. Two other towns take a supply of coke oven gas from this main, between the coke ovens and Darlington.

The input of gas is passed through a non-return valve and volumetric governor before entering the works mains, prior to purification. The coke oven gas, as received, has a calorific value of 515 to 525 B.Th.U. per cu.ft., and has an average content of 2 grains of naphthalene per 100 cu.ft. The sulphur compounds in the gas after purification are about 5 grains per 100 cu.ft., and the total inerts 10% to 13%.

Many attempts have been made to introduce new processes for the removal of sulphuretted hydrogen from town gas, but iron oxide in its various forms is still universally employed for this purpose. Apart from slight modifications which have been introduced at various times, the method of purification has not been altered greatly during the past 30 years.

Since the supply of Dutch and Belgian bog ores has been lost to this country, many undertakings have been compelled to rely very largely upon artificial oxides. The labour charges of more frequent changes of the material are an extra charge on purification. With the present-day practice of removing practically all the ammonia from the gas before entering the purifiers, the material often becomes acid, thus rendering the purification process more difficult. Many attempts have been made to overcome this, and the addition of a little soda ash (say 4 cwt. per 100 tons of oxide) renders the material alkaline and generally more efficient as a purifying medium. By-passing the tower scrubbers or ammonia washer for a short time, in order to revive any sour material in the purifier, is always open to those works making their own gas, but with those undertakings receiving coke-oven gas other means must be found.

With the higher value received for spent oxide, due to war conditions, and with the reduced costs, owing to efficient revivification *in situ*, it has, in many cases, been almost possible to show a profit on purification.

Darlington, having increased the area of gas supply during recent years, found that many rapidly growing districts on the outskirts of the town were subject to a diminution of pressure, particularly during the peak load hours, which it was impossible to overcome entirely by ordinary transmission from the holder through the station governor, although we considerably increased the town pressure at the midday period to meet the cooking load.

It was eventually decided to have a ring main around the town, fed by 6-in. high pressure mains. The gas is compressed at the works employing a pressure of 3 lb. per sq.in. The low-pressure mains are fed through district governors fixed at a number of points. These governors are housed in either an underground chamber or a kiosk above ground, the latter having many advantages over the former. It was found necessary to run the compressors from 6.30 a.m. to 2 p.m. daily, and this high-pressure system of gas transmission has proved a very valuable supplement to the ordinary town pressure, and has largely overcome the difficulty of maintaining adequate pressures at certain periods of the day, and done away with the necessity of laying large trunk mains to these outer districts in roadways or footpaths already overcrowded with other pipes.

* From an Address as Chairman of the North of England Gas Managers' Association (Auxiliary Section).

The Board of Trade announces that the Limitation of Supplies (Heating Apparatus) (No. 3) Order (S. R. & O. 1943, No. 1613) is now obtainable from the Stationery Office, price 1d. This Order continues without alteration the existing control on the supply of gas and electrical space-heating apparatus of the kind used for domestic purposes, for the period of restriction beginning with Dec. 1, 1943, and ending with May 31, 1944.

The Institution of Mechanical Engineers announces that, thanks to arrangements made by the War Organization of the British Red Cross and the Order of St. John of Jerusalem, no less than 37 candidates recently sat for the Institution's examinations in prisoner-of-war camps in Germany. No fewer than 34, or 92%, passed with an exceptionally high average percentage marking. The results reflect credit both on the candidates and on members of the Institution and others in the camps who organized classes and acted as instructors.

The Plymouth and Stonehouse Gas Light and Coke Company has decided to pay a dividend on Jan. 1, 1944, for the half-year ended Sept. 30 last, at the rate of £4% per annum on the Ordinary Stock, 6s. per share on the "Additional" Shares, and 5s. 6d. per share on the New Shares, Act 1879, less income tax at 10s. in the £. For transferees to receive this dividend, transfers must be lodged at the Company's Offices not later than 5.30 p.m. on Dec. 13 next.

Members of The Institution of Gas Engineers are invited to attend a Joint Meeting of the Illuminating Engineering Society with the Association of Public Lighting Engineers to be held on Dec. 14 at 5 p.m. at the Institution of Mechanical Engineers, Storey's Gate, S.W. 1. A discussion on "Street Lighting Specifications of the Future: Should they be based on the Design of the Unit or the Effect of Illumination?" will be opened by Dr. S. English and Mr. R. Maxted. Cards of admission may be obtained from the Secretary of The Institution of Gas Engineers, 1, Grosvenor Place, S.W. 1, or direct from the Hon. Secretary of the Illuminating Engineering Society, 43, Victoria Street, London, S.W. 1.

The fact that goods made of raw materials in short supply owing to war conditions are advertised in the "Journal" should not be taken as an indication that they are necessarily available for export.

COKE AND OTHER MATTERS*

By H. H. THOMAS, B.Sc.,
Liverpool Gas Company

WE must assume that the Ministries concerned (*i.e.*, Fuel and Power, Health, and Works and Planning) will encourage the gradual abolition of smoke from the atmosphere. The waste of fuel, the injury to health, and expenditure incurred upon cleaning and replacement of material deteriorated by the presence and deposition of dust, tar, and sulphur oxides from domestic smoke, are factors which demonstrate the necessity for such a policy. It is, in fact, surprising that some great official interest has not previously been taken in this pollution, the extent and cost of which has been computed at intervals during a considerable period. Smoke elimination will be a long-term policy which will benefit succeeding generations, but we can assist materially in its establishment and development.

The fuels which we produce are complementary. The combination of gas and coke is capable of providing every heat requirement in the modern home; gas for cooking, water heating, and intermittent and background space heating, and coke for the open fire, the basic heating of water, and central heating. It possesses the very great advantage from the national, consumer's, and producers' point of view that, as the revenue from coke increases, the cost of gas is reduced and the potential consumption of both fuels is increased, which may further reduce the price of both.

The present is an abnormal and perhaps unfortunate moment to discuss coke, but we can imagine a very different position prevailing now had more energy and interest previously been directed towards the production and preparation of coke. Mr. J. G. Bennett has asked whether coke has a future or only a past, and he decided that it definitely has a future, although his conclusion was not confined to the domestic market or to the open fire. We can be certain that at least one open fire will be installed in the post-war British home, although it most probably will not be eliminated from the majority of existing dwellings ; even so, this is our primary and greatest market.

It has been proved in Liverpool, Edinburgh, and elsewhere that a highly satisfactory open grate fuel can be manufactured by carbonization of selected coal under slightly modified conditions relative to normal gas production practice. This proposition refers particularly to carbonization in vertical retorts, while coke prepared in horizontal retorts or coke ovens can be modified to the desired quality by activation with alkali.

The properties of this fuel may be recorded.

Bulk density—as high as possible.

C.A.B. cu.ft. per min.	0.04	Ash	7%
H_2O	5%	V.M.	2–3.5%
		Grading	¾ in.–2 in.

The economics of the production of this fuel cannot be doubted when account is taken of the enhanced value of the coke (and its value is enhanced if it merely commands a ready market), the increased output of the gas-making plant (in certain circumstances), and the reduced cost of repairs and renewals thereon.

As an alternative to this proposal the production of less combustible coke of controlled quality and size grading will be continued (C.A.B. 0.055–0.065). The sale of this for open fires will depend upon the installation of a special grate which will perhaps be an obstacle to a really extensive demand. This policy has, however, been very successfully pursued in some areas, and the desirable procedure may perhaps be defined by the Coke Quality Committee of the Institution, whose further conclusions we may hope will not be long delayed.

The further major domestic consumption will be for the supply of hot water. Here again it is unlikely that a high proportion of existing installations will be modified, but the post-war dwelling may well be fitted with a small coke boiler or stove with which the boiler is incorporated. These appliances enable the rate of combustion of the fuel to be exactly controlled, they remain permanently in operation, and can be devised to supply some small degree of central heating by water circulation. There are some admirable modern examples already in existence which, we may be sure, will be appreciated by the architect, the builder, and the occupier of the smallest post-war home.

The P.E.P.† report of 1939 stated that "the use of coke in the open grate is of particular interest, since it represents one possible method of eliminating the most prolific source of smoke—the open coal fire. The Gas Industry, unlike the low temperature carbonization industry, has a very large manufacturing capacity, and could at once go a long way to provide adequate supplies if the fuel provided was acceptable to the public. Coke of the right quality and suitably graded can already be burnt very satisfactorily, from the point of view both of efficiency and appearance, in modern coke grates. Further improvement of quality and extension of these improvements throughout the Industry should result in a far more widespread use of this fuel."

This is the proposition which I wish to emphasize, and while we must hope to have the necessary co-operation of the coal industry and the Ministry of Fuel to provide de-ashed coal of selected type, the major responsibility will be ours, first to produce the coke, and secondly to advise, instruct, and inform the consumer of the individual and communal benefits which will result from its use.

A further extract from the P.E.P. report indicates the magnitude of the expansion which is possible: "The average household in this country consumes fuel equivalent to 270 useful therms per annum (*i.e.* therms actually transferred to the air for warmth, into hot water, or usefully employed in cooking)." This total was distributed between the various fuels as follows:

Gas	18.5%	Anthracite	4.0%
Coke	18.5%	Electricity	2.5%
Coal	52.5%	Oil	4.0%

We shall be judged by posterity upon the extent to which we can transfer the consumption of 142 useful therms per household per annum from coal to coke or gas. If a utilization efficiency of 60% is assumed for gas and 30% for coke this is equivalent to an additional requirement of either 237 therms of gas or 474 therms of coke (=1.7 tons) per household.

We are not, of course, at present in a position to supply this quantity of heat, but our production will develop by our creation of the demand, and we must proceed, therefore, upon the assumption that we propose to supply this load, most probably in conjunction with the coke oven industry.

Prior to the war the average consumption of gas by domestic consumers was estimated to be 100 therms per annum, whereas the actual consumption at Kensal House* was 220 therms of gas and 400 therms of coke, gas being used exclusively for the heating of water. This demand was, of course, primarily made possible by the establishment of a two-part tariff, which it is not my purpose to discuss to-day. The gas consumption figure does indicate, however, the potential market which is available, and it could quite definitely be set considerably higher than this, to the extent that there will be a demand for greater domestic convenience and comfort in the future, and further to the extent which demand is created by "Service."

"Gas Service" is a wide term, but it may be defined as "the procedure and provision necessary to ensure the absolute consistent and reproducible operation of any and every gas appliance whenever its use may be demanded by the user."

The water heater which delivers 2½ gall. of water at 110°F. at midday must likewise deliver the same quantity at the same temperature at midnight. The hotplate burner which raises 4 pints of water to boiling in 11 minutes must reproduce this at any time. Similar consistency must be achieved with every other appliance.

In the first place gas quality in every respect must be constant, the pressure of supply must be properly governed, and the sulphur content must be properly governed and must be low.

The formation of the Gas Research Board in 1939 was a milestone in the history of the Industry. Unfortunately, circumstances have prevented development, but a Director has been appointed, and plans for the future are being prepared. Not the least valuable of the already expressed intentions of the Board is that of providing a central bureau of information which will be available for consultation by members. This is a facility which will save a vast amount of time by avoiding repetition of literature abstracting and experimental work. The Director has called for the most intimate interest and collaboration of technical staffs in the work of the Board, and there is no doubt that therein lies the origin of future improvement of our processes.

If we consider these matters it is obvious that there are great opportunities for the individual in every department of the Industry. The primary needs are energy and knowledge, and these qualifications cannot be more usefully directed towards the service of the community in any other industry. We may all, therefore, safely encourage the entry of promising juniors to our service with the knowledge that their talents will be utilized to the full. In conclusion, I would quote a trite remark, which is applicable equally to the Industry and to the ambitious junior:

> " Remedy your deficiencies and your merits will take care of themselves."

* From a Presidential Address to the Manchester and District Junior Gas Association.

† *Political and Economic Planning. Report on the Gas Industry.*

* Kensal House, London.

An Assembly of over 500 industrial and Trade Union representatives of factories in the Manchester area gathered together on Nov. 24 to hear details of the present coal position explained by Mr. Gordon Macdonald and Mr. F. H. Lucraft, of the Ministry of Fuel and Power. The meeting, held at the Houldsworth Hall, was opened by the new Lord Mayor, Alderman Leonard B. Cox. Sir Frederick West, Deputy-Chairman of the Regional Board, spoke on the relation between production and fuel economy, while Mr. C. T. S. Arnott, District Manager of the Central Electricity Board, dealt with the increase in consumption of electricity. Also present was the Chairman of the Fuel Efficiency Committee, Mr. P. D. Kirkman, who revealed that further economies in consumption could and must be made throughout industry.

SOFTENING, CONDITIONING, AND CONTROL OF BOILER FEED AND BLOW-DOWN WATER*

By K. R. MORTIMER, March.

(*Continued from p. 656*)

A third process which generally will only be found in use in large steam-raising plants is a combination of the two processes already mentioned and is known by one of its manufacturers as the lime zeolite process. This process is especially suitable for water with a high bicarbonate hardness. First of all the raw water is dealt with in a lime-soda plant such as has been described; following this, pressure type sand filters are usually employed to remove all traces of precipitate in the water before passing on to the base exchange plant. This is essential, as the zeolite bed can be easily ruined if the lime-soda process is not completely stabilized before the base exchange part is reached. The grains of zeolite would become coated with calcium carbonate, or any overdose of lime added may be absorbed by the zeolite and then react with any residual carbon dioxide in the water, when the whole bed will become cemented together in a mass of crystalline calcium carbonate.

The advantage of this combined process is that not only is the water reduced to zero hardness, but in addition it is entirely free of precipitate and the quantity of soluble salts is very small. This process, however, involves a large capital cost and a considerable amount of technical control, and is quite unsuitable for the steam plant found on most gas-works.

The demineralization of water : This process is quite new, and is the result of some years of research by one of our biggest water treatment plant manufacturers, the Permutit Company, Ltd. The process removes the impurities and salts contained in all natural waters, the resulting effluent being similar to distilled water. One important point is that this "demineralization" can be carried out completely or carried just as far as may be necessary to prevent deposition of scales in boilers, economizers, super-heaters, &c. The point is that the salts in the water are actually removed, not exchanged or substituted, and changes are effected in the raw water which had previously been possible only by distillation.

In a few words, what happens is that the process is capable of first exchanging the cations in the water for the hydrogen ions, and then removing the anions formed. The water is thus deprived of all its dissolved salts; thus changes are effected in the raw water which have not been possible hitherto without distillation—for example, the removal of sodium bicarbonate, sodium chloride, lime, magnesia, &c.

The chemical reactions in the plant are as under:

$$\left.\begin{matrix}\text{Calcium}\\ \text{Sodium}\\ \text{Magnesium}\end{matrix}\right\}\text{Bicarbonate} + H_2Z = \text{Water} + \text{carbon dioxide} + \left.\begin{matrix}\text{Calcium}\\ \text{Sodium}\\ \text{Magnesium}\end{matrix}\right\}Z.$$

Similarly with sulphates, the salts being converted into the corresponding acid—sulphuric—the chlorides going to hydrochloric acid. Thus the water issuing from this first stage in the process is acid in reaction where it was previously alkaline. This water is then further treated in a second pressure cylinder which contains a bed of acid absorption material; here all the acids formed are absorbed, leaving only the carbon dioxide, which is dealt with in a final stage of a cold degasifier. The resultant product is a water free of mineral content, and it is possible, if required, to produce a water of greatly reduced total solids, of zero hardness, and of any alkalinity required.

This plant can be regenerated in a somewhat similar manner to the base exchange plant when the material in the pressure cylinders becomes exhausted, except that the first hydrogen ion, or HI unit as it is called, is regenerated with a dilute solution of sulphuric acid instead of salt solution, and the second, which removes the anions formed, known as the D.W. unit, is regenerated with soda ash. This process has been applied to drinking water supplies of one million gallons per day, and one plant has been applied to a boiler installation at a large power station where 72,000 gallons of make-up water a day are dealt with. This plant is reducing the total solids in the water from 4.7 to 1.1 parts/100,000.

Choice of Softening Process

The choice of softening process will depend on several factors, principally the composition of the raw water supply. It is therefore essential, before coming to a decision on which process to employ, to obtain adequate data on the water to be treated.

First of all, river water or any source of water partly consisting of surface or rain water will vary a good deal in its analysis; therefore when water of variable composition such as this, or one or more alternative sources of water are to be used, the base exchange process will be found the most suitable. This plant is also the most suitable for waters of high permanent hardness or high magnesia content.

Waters of high temporary hardness should not be dealt with in the base exchange plant, as the bicarbonates causing this state will all be converted eventually in the boiler to sodium carbonate, with resultant trouble due to high alkalinity of blowdown. Such a water as this would probably be best dealt with by the demineralization process, as the bicarbonates are then completely removed.

The cold lime-soda process is not considered suitable for any stationary boiler plants to-day, as the hardness of the effluent is comparatively high. Up to the present time all waters high in temporary hardness have been dealt with by the hot lime-soda process, but to my mind the demineralization process may bid fair to oust the lime-soda plant from this type of treatment.

Conditioning of Water

Although softening of a water may be said to be part of its conditioning for boiler purposes, I have here applied this term to some well used and well tried systems which are not strictly speaking "softening" processes. There are one or two of these which depend on electrical potential being passed to the water.

There are two main systems of this nature known to the writer. The general outline of these processes is that the water is caused to pass over in close proximity to an electrode charged to a critical potential; this potential is very small—of only a few millivolts. The effect of this is said to be the transformation of the state of solution of mineral salts in the water from normal solution to colloidal solution, these impurities being deposited as a fine sludge on evaporation and concentration in the boiler.

Some of these processes depend on outside batteries or electric cables for source of power, and at least one on the production of an electrostatic charge by friction; one or two installations of the latter type are, I believe, at work in the Eastern Counties.

To pass on to a real conditioning process, we have the various types of tannin conditioning. The effectiveness of these treatments varies a good deal, but they have proved quite successful in many cases, the idea being that the tannin, being present inside the boiler, coats and is absorbed by any solid particles, which separate out and prevent them adhering to the boiler metal. They are also said to form a protective film on the boiler surface and so inhibit corrosion of the metal. However this may be, it seems to me far preferable to stop these harmful elements from getting into the boiler at all rather than try to neutralize their effect when there.

On many boiler plants condensate from steam engines, turbines, and process work is returned into the feed water system. This is a very good plan to follow, especially when the condensate is free from oil, as the water is practically free from dissolved salts and is thus non-scale forming in the boiler. Unhappily rendering the condensate free from oil is no talways an easy matter, especially when the mixture has become emulsified; and thus unless special conditions are obtaining the return of condensate is only practised on large steam-raising plants. The method of rendering such water free from oil is by coagulation, the treatment consisting of adding a measured quantity of sulphate of alumina and soda ash in a plant of similar type to that for the lime-soda softening process. The two processes are in fact often carried on side by side in a combined plant.

Control

For the maximum benefit to be derived from conditioning and softening boiler water all the processes used must be carefully controlled—if they are not disappointment will follow, and the results will be uneconomic.

Before passing on to the tests required to maintain our conditions let us recapitulate the basic facts:

The hardness of waters is due to the presence of calcium and magnesium salts in solution. These can be divided into two main parts:

1. Carbonates of both elements usually held in solution as bicarbonates by being combined with carbon dioxide.

2. Salts of both elements held in normal solution, principally the sulphates, chlorides and nitrates.

Group 1 are those responsible for the so-called *temporary hardness*, as on heating the CO_2 is driven off and the bicarbonates, being converted to carbonates and being insoluble in this form, are precipitated. This is not really an actual fact, as in practice magnesium carbonate and calcium carbonate are both soluble in water to a small extent. It has, however, become the practice to refer to bicarbonate hardness as determined by titration with acid as temporary.

Group 2: The salts contained in this group—namely, the salts held in normal solution as chlorides, nitrates, &c., of magnesium and calcium—are unaltered by heating to boiling-point, and so these salts constitute the permanent hardness of the water.

Now to what are we referring when we talk of the hardness of a particular sample of water? We find it expressed in two ways: first as degrees of hardness where 1° of hardness is the hardness caused

* From a Paper to the Eastern Counties Gas Engineers' and Managers' Association, Nov. 17.

by calcium and magnesium salts in the water equivalent to 1 grain of calcium carbonate ($CaCO_3$) per gallon. Secondly as parts of $CaCO_3$ per 100,000. This is the more recent practice, and I propose to use this standard throughout this Paper.

The relation between these two forms may be summed up as 1 part of $CaCO_3$ per 100,000 is equal to 0.7 degree where 1° English equals 1.0 grain of $CaCO_3$ per gallon.

I now propose to deal with the tests require df orcontrol of water-softening processes and to carry on later with those necessary for control of blowdown.

Tests for control of water softening: These I have divided into two groups—(*a*) raw water, (*b*) softened water.

(a) *Raw water.*—We require to know: (1) Temporary hardness—*i.e.*, total alkalinity using methyl orange indicator. (2) Total hardness. (3) Hardness due to salts of calcium. (4) Hardness due to salts of magnesium.

(b) *Softened water.*—(1) Total alkalinity to methyl orange. (2) Caustic alkalinity. (3) Residual hardness due to (*a*) calcium salts, (*b*) magnesium salts.

The ideal practice would be to carry out these determinations once per day, but this is, I am afraid, a counsel of perfection, and if the raw water supply is of reasonably constant composition, a complete test once per week should give reasonably efficient control.

Now, to run briefly through the method of test on raw water: Firstly, all receptacles used should be perfectly clean and all sample vessels well swilled out with the water to be tested. It is also advisable to filter the water before analysis, and here let me give a word of warning. It has been my experience that filter-papers kept in gas-works' laboratories become saturated with ammonia, which will not tend to make your tests more accurate. It is as well, therefore, to check up on your filter-papers first when doing water analyses of any description in a gas-works laboratory.

To determine temporary hardness titrate 100 ml. of the water sample with N/10 nitric acid, using methyl orange as indicator, until the neutral point is reached. Then such is the convenience of this method, 5 times the number of ml. of acid used gives the figure of parts of $CaCO_3$ per 100,000. This figure then gives us the temporary hardness of the sample except in one special case—*i.e.*, when sodium bicarbonate is free in solution in the sample. When this is the case the total alkalinity will be found to exceed the total hardness. Then the hardness is entirely temporary and due to free sodium bicarbonate in the water, causing the excessive alkalinity. This case often occurs in the deep well waters.

Total hardness: This determination is carried out on the neutral liquid left from the previous determination. Four drops of N/10 nitric acid are added, which should make the liquid definitely acid and restore the pink colour of the indicator. Boil this for one minute to expel CO_2. When cool add 1 ml. of 1% phenolphthalein indicator and neutralize the solution by adding N/10 caustic soda until the yellow colour appears. Continue adding the caustic soda until the pink reasserts itself, when this is destroyed by one drop of the N/10 nitric acid. The solution is then neutral. This is now titrated with N/10 potassium palmitate solution until a pink colour appears. All the hardness has now been precipitated and the number of ml. of palmitate used is noted. Five times this figure gives us the total hardness in parts of $CaCO_3$ per 100,000.

Then permanent hardness will equal total hardness less temporary hardness.

Hardness due to lime salts: For this test 100 ml. of sample are first neutralized in presence of methyl orange as indicator. CO_2 is then expelled by being boiled for 2 minutes. Proceed as in previous test up to the point where the pink indicator colour of the phenolphthalein reappears. Add 6 ml. of caustic soda N/10 and boil for a further minute; add 1 ml. of 0.28 sodium aluminate solution; cool and again titrate with potassium palmitate. Multiply the number of ml. of palmitate used by 5 and the resultant gives the hardness due to lime salts, expressed as parts of $CaCO_3$ per 100,000.

Hardness due to salts of magnesium: This is obtained by deducting the last figure from the total hardness.

Tests on the Softened Water

These tests are carried out in a similar way to those on the raw water: the determinations required are: (1) Total alkalinity. (2) Caustic alkalinity. (3) Total hardness. (4) Hardness due to lime salts. (5) Hardness due to salts of magnesium. The only additional determination is that of caustic alkalinity.

First of all the sample is tested to see if caustic alkalinity is present. To 200 ml. of the softened water add 10 ml. of 10% barium chloride solution and one drop of phenolphthalein indicator; if no pink colour develops then caustic alkalinity is not present. If the sample gives an alkaline reaction it is then titrated with N/10 nitric acid until the pink colour just disappears. Then the number of ml. of acid used is multiplied by 2.5 to give the equivalent in parts of $CaCO_3$ per 100,000.

Control of Blowdown

Concentration of dissolved salts: The concentration of dissolved salts in a boiler naturally increases due to evaporation of the water. This will continue until a point is reached when, in conjunction with the solids in suspension in the boiler water, foaming and priming will occur. The water will also have a high alkalinity, which will vary directly as the concentration. To limit the rise in concentration is the purpose of blowing down a boiler; this is a very haphazard operation on a good many boiler plants, and it is rather doubtful if one long blowdown per day is an efficient method, as deposited solids on the floor of the boiler are only removed for a short distance around the blow-off outlet.

This has led many people to the principle of blowing down at frequent intervals for a short time. This idea leads to the only logical end of continuous blowdown, which when properly regulated is not only the most efficient, but a great saving in heat, the heat loss being only about 1.5%. An easy check on blowdown can be carried out by determining the total chloride content in the feed water and in the blowdown water. As chlorides pass through the boiler almost unchanged the blowdown can then be controlled to maintain these two figures in constant ratio.

A rough and ready method of control of concentration is to weigh a small specific gravity bottle full of a cooled sample of blowdown water, and compare with the weight of the same volume of distilled water at the same temperature. In other words, control the specific gravity of water. This method suffers from the disability that the standard of control bears no relation to the feed water.

So much then for control of concentration in the boiler; let us consider the matter of scale prevention.

We have discussed the types of scale commonly found in boilers, one of the most common being calcium sulphate scale. The controlling factor in this case is the sodium carbonate content of the feed water. It has been shown by Clarke and Hunter, among other workers, that if sufficient of this substance (sod. carbonate) is present, then any calcium present will be deposited as calcium carbonate, which is comparatively harmless, being precipitated as a light powder, tending to remain in suspension. This balance may be upset, however, inside the boiler by the decomposition of the sodium carbonate. This state of affairs can be remedied by a conditioning of extra sodium carbonate. When the sulphate is being held in solution in the boiler we shall be able to test for it in the blowdown water with positive results, and the ratio of sulphate in feed to sulphate in blowdown should be equal to the chloride ratio already mentioned. We then have to make four determinations to control this condition—namely: (*a*) Chloride in feed and blowdown, (*b*) sulphate in feed and blowdown—and then to calculate the corresponding ratios.

To evaluate these results take the figure resulting from the chloride in feed-chloride in blowdown ratio and multiply this by the sulphate content of the feed; this gives the theoretical sulphate content of the blowdown which should agree with the figure determined by test, if there is no deposition of sulphate scale. When the figure determined by test is less than the theoretical figure, sulphate scale is being formed; on the other hand if it prove greater, old scale is being dissolved.

One type of scale referred to earlier was silicate scale; this is found in actual practice as a thin, very hard, glass-like scale. If scaling persists in spite of the sulphate condition being under control it is almost certain to be a silica scale. The only method I know of or can trace as having been effective is conditioning the water with sodium phosphate. The amount added has to be sufficient to give a concentration of PO_4 ions of not less than 5 parts/100,000 in the boiler water.

Control of caustic embrittlement was discussed by Jones in a Paper in the *Fuel Economy Review*, and he gives figures for sodium carbonate to caustic soda, and sodium sulphate to caustic soda ratios in the boiler water which should not exceed certain figures. A ready method of check is to maintain the ratio Na_2SO_4 to Na(OH) in the boiler water at a figure greater than 2.5 by the addition of sodium sulphate. This will ensure the condition of the water remaining in the non-embrittlement area.

For the determination of these ratios the following tests are required: (1) Total alkalinity of blowdown water. (2) Caustic alkalinity of blowdown water. (3) Chloride in blowdown water. (4) Chloride in feed water. (5) Sulphate in feed water. (6) Sulphate in blowdown water. Of these the alkalinity tests are carried out in the same way as those previously described, but it is desirable to dilute the boiler water down, say, 20 ml. diluted to 100 ml. in order to give a paler colour, otherwise it is almost impossible to see the colour change when the end-point is reached. The calculation is, of course, affected and has to be corrected.

The determination of chlorides is carried out on a concentrated sample acidified with N/10 nitric acid and titrated with N/10 silver nitrate solution, using potassium chromate as indicator. When 100 ml. of boiler water are used originally the numbers of ml. of silver nitrate used gives us chlorides as ml. normal per litre. Determination of chlorides in blowdown is carried out in the same manner except that the sample is not concentrated and only 20 ml. are used. Multiply number of ml. of silver nitrate used by 5 to obtain the result in ml. normal per litre. The necessary ratio is then easily calculated from these results, namely:

$$\frac{\text{Chlorides in blowdown}}{\text{Chlorides in feed}} = \text{R.}$$

Determination of Sulphates

Having calculated our chloride ratio the theoretical sulphate content of the blowdown water will be—

RX4 (ml. of palmitate used+10−ml. of palmitate used after precipitation sulphate).

All palmitate figures being on feed determinations.

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This should be within ± 10 parts per 100,000 of the actual figure calculated as under:

40 (ml. of palmitate used + 20 — ml. of palmitate used after precipitation of sulphate).

All palmitate figures being on blowdown determination.

The additions in each calculation of 10 and 20 respectively are due to barium chloride added during the test.

The sodium sulphate: caustic soda ratio and the sodium carbonate: caustic soda ratio can now be calculated. It should be realized that generally speaking sodium carbonate is the root cause of caustic embrittlement, and its use as a softening or conditioning agent will always entail a risk of embrittlement conditions arising.

As we have seen, sodium carbonate will prevent the deposition of sulphate scale, but this cannot be relied on as a reagent for this purpose as it is split up under boiler conditions. As carbon dioxide is corrosive to iron and sodium carbonate does not control silicate scale, its use is not recommended. For this reason great care in analysis of a water should be taken before a lime-soda softening plant is installed.

Finally, to sum up, the final water fed to the boilers after treatment is at best a compromise. It will be realized from the foregoing that to overcome scaling completely some other trouble such as corrosion will be set up, and we have therefore to try and pump into our boilers a water so treated as to cause as little trouble in each direction as possible. A good boiler water then should have approximately the following characteristics:

Definite caustic alkalinity of pH value about 8.5 or not more than 0.5 grain per gallon; total solids kept at the lowest possible figure; dissolved oxygen less than 0.1 c.c. per litre. A water kept to this standard would give the minimum of trouble.

DISCUSSION

Mr. **J. Hunter Rioch** (Cambridge) said the Paper was an interesting and useful summary of modern water-softening processes, and a useful reference to those operating or considering the installation of plant most suited to their requirements. At various points in his Paper the Author sounded notes of warning with which engineers who had had practical experience in dealing with this rather complex subject would thoroughly agree. His (the speaker's) experiences in Cambridge on the subject bore out the general impression created in the Paper—namely, that adequate softening and control of boiler water conditions was a somewhat complicated process requiring a good deal of technical supervision, especially where one was faced with a water of varying composition. The importance of proper softening could not be over-emphasized, and in his opinion there was only one place to treat water, and that was outside the boiler. Boiler compounds were, generally speaking, unsatisfactory, and were wrong in principle. The hardness forming salts must be removed before water entered the boilers. The effect of boiler scale—especially silica scale—on heat transfer was an extremely serious matter, not only on the grounds of fuel economy, but on account of the overall effect on the thermal efficiency of the undertaking. It was not enough to produce good thermal yields from the carbonizing plant if at the same time the overall fuel consumption of a works was inflated by high consumptions of fuel for steam raising. What did appear to be necessary was a water-softening plant which, besides being efficient, was simple in operation, reliable, and required the minimum of technical control. The residual hardness figures given in the Paper for a cold lime-soda process appeared high. At Cambridge they had a plant which regularly produced a softened water of about 2° hardness. When installing this type of plant it was essential to have adequate space for removal of the precipitated sludge. The summary of test methods given by Mr. Mortimer was useful as a reference, but to him it seemed rather a pity that the better-known tests are given in such detail to the exclusion of the less usual sulphate tests. It was not clear whether Mr. Mortimer had in fact installed a softening plant at his present works, but in view of the nature of the water at March, it was presumed that he was contemplating the installation of a suitable plant. Could he ask what type of plant the Author has in mind to install. It would also be interesting to know why N/10 acid was used in the tests when dealing with raw water, instead of N/50, which would give a direct reading. Finally, could Mr. Mortimer give any information on capital and operating costs—especially the latter—of the various systems he had so adequately described?

Mr. **T. C. Battersby** (Watford), remarking that many had not given the amount of attention to water softening which they should have given, said they would all look forward to the day when they had demineralized feed water. Boiler feed conditioning required constant care, for there were variations of from 2° to 3° in hardness from the same source of supply. He thought the best overall performance was given by the hot lime-soda process. The Author had mentioned electrical treatment, and he wondered how the electrical effect achieved the results claimed for it, for it must necessitate more blowing-down. A scale temperature of 480°C. had been stated as a critical temperature, and he would be glad to have information concerning the temperatures reached by scales of different qualities and thicknesses.

Mr. **Mortimer**, in reply, said that at the moment no water-softening plant was employed at March, but he would favour the installation of a base-exchange plant. He had, unfortunately, no figures relating to costs of operation. It was a matter of custom that he used N/10 acid rather than N/50, and the former was more easily made-up than N/50. He had been informed that the demineralization process was expensive to operate. Regarding electrical processes, he had no liking for them, for they necessitated extra blow-down and consequent loss of heat.

Mr. **G. B. L. Wilson** (King's Lynn) remarked that the Author had not mentioned the sodium hexa-metaphosphate process or the use of linseed, and Mr. **F. H. Robinson** (Bishop's Stortford) asked whether he had any experience of scale buoys, to which Mr. **Mortimer** replied in the negative.

Mr. **Robinson,** commenting on the difficulty of dealing with precipitate, said that he had found wood-wool filters inadequate, and thought the solution might lie in the use of secondary filters on the lines of water-works practice. There was also the problem of soft waters giving an acid reaction, which type of waters attacked rapidly cast iron and also copper alloys.

Mr. **W. J. C. Garrard** observed that the Author had not referred to the continuous blow-down system, which, though it required care in manipulation, proved a good proposition with suitable water. He suggested that the methods of analytical control outlined in the Paper were hardly suited to the smaller works, though the problem of water treatment was in fact just as important to the small works as the large.

Mr. **W. H. Blundstone** (Newark) said that though in principle he agreed that softening of boiler feed water should take place outside the boiler, he was carrying out his precipitation inside the boiler, and with good results. By the method employed a brown mud was formed which was removed by attending regularly to blow-down each shift.

Mr. **Mortimer** said he stuck to the point that it was preferable to carry out water treatment, not inside the boiler, but outside.

Mr. **Wilson** spoke of water, saturated with carbon dioxide, which quickly corroded steam fittings, and Mr. **Mortimer** suggested that fittings of wrought iron might prove suitable in these circumstances.

Mr. **D. M. McCaskill** (East Lynn) said it occurred to him that water engineers had not contended with their job of supplying suitable water as gas engineers had met their task in supplying suitable gas. He thought that cold systems of softening could be made efficient by using the correct materials and quantities of reagent—perhaps eventually more efficient than the hot system. Certainly, on the question of filtering, the cold method gave the best results. Finally, regarding water supply, why did not gas-works favour sinking boreholes?

Mr. **Mortimer** replied that gas-works were sinking boreholes where such a course was practicable, but in some districts it was not practicable.

Mr. **Rioch** proposed a vote of thanks to the Author. Mr. **Battersby** seconded, and Mr. **Mortimer** replied.

Mr. **F. Allen** (Clacton), in a written contribution to the discussion, stated: While Mr. Mortimer has pointed out the troubles which may occur in boiler practice when a water has a high CO_2 content, I find it a matter of some regret that he has not emphasized that troubles caused by CO_2 can be seriously increased when boiler waters are treated in a zeolite plant. With this type of softening, free carbonic acid is not removed from water as in the process of lime softening—in fact, in some cases decomposition of the sodium bicarbonate formed by zeolite softening can occur in the boiler with the formation of additional carbon dioxide. I was particularly interested in the Author's comments on aeration of waters and consequent dissolved oxygen. I once experienced a somewhat disastrous occurrence through water which was being aerated quite unwittingly being fed to steam boilers. This water had no visible effect on boiler shell or flues. The free oxygen obviously went forward with the steam. This steam caused oxidation of the shaft of a 10 h.p. de Laval type steam turbine. The shaft broke and the turbine wheel flew into fragments, fortunately without causing any personal injury. Subsequent examination proved that serious corrosion had taken place on the shaft immediately against the turbine wheel, where the steam is comparatively still. A close examination of the boiler feed system disclosed that the water, before reaching the boiler, passed through two ball valves fitted so that water splashed from them into the tank below. On this particular installation this was the only point where there was any likelihood of the water taking up excess oxygen. After the occurrence tail pieces were fitted to these ball valves to cause them to discharge below the normal water line and no further trouble was experienced.

I regret that in the brevity of Mr. Mortimer's remarks on conditioning of water he has not found space to discuss more fully the treatment of boiler waters by addition of chemicals to the feed water. That boiler feed water can be treated without any water-softening plant is obvious to anyone who has studied this subject, and carefully balanced chemicals can be obtained to prevent scale formation from any particular water. I have no desire to discuss the merits or demerits of combining water softening with steam generation inside a boiler. That it can be done satisfactorily and without any injurious effects to the boiler I have proved by an experiment which has now lasted for some years. These processes require careful chemical control of dosing, exactly the same as any other system of feed water treatment. The day-to-day costs are higher than those where a softening plant is used, but when it is borne in mind that there are no capital or plant maintenance costs they do not compare unfavourably.

Mr. Mortimer mentions systems of water conditioning depending on electrical potentials. I have no practical working knowledge of these particular systems, but at different times my attention has been drawn to various suggestions for water treatment without the use of

chemical additives or outside electrical current. I have yet to find one of these systems which has proved satisfactory with a difficult water, and am inclined to regard them as "faith cures." My only regret is that the average scale-forming salts are so lacking in "faith" as to be unaffected by these "cures."

I rather agree with the analyst's comment on the somewhat amazing sample of March pond water when he states that the amount of blow-down must be controlled by the solid content, and not merely by the alkalinity, and in this respect would like to learn from Mr. Mortimer what he considers is the most desirable ratio to be obtained between chlorides in feed and chlorides in blow-down.

I would also like to ask if Mr. Mortimer can tell us anything of possible dezincification troubles with boiler fittings due to excessive chloride content of boiler water.

Mr. **Mortimer,** replying to Mr. Allen, wrote: Mr. Allen's remarks on the failure of a De Laval steam turbine are very interesting. I think in addition to what he did I should have taken steps to air-vent the steam line. With regard to turbine failure, priming and foaming in the boiler can also cause trouble, as due to the heat in the turbine itself all solids carried over due to these effects become dry and dust-like, and a sand-blast effect is obtained inside the machine, the results of which will be obvious.

With regard to Mr. Allen's regret that more was not said about conditioning inside the boiler, this brevity was intentional, as I do not consider the boiler the place to carry out water treatment; in any case either more blowing down has to be done, with consequent loss of heat, or danger of priming and foaming conditions be run. Mr. Allen's last two questions, chloride in feed: chloride in blow-down ratio—this ratio should be kept as constant as possible. The chloride in blow-down will obviously always be the higher, but no actual ratio could be given without knowing the amount of chloride in the feed water. Naturally the higher the ratio, the greater the concentration; this should be kept as low and as constant as possible with appropriate alkalinity.

Concerning dezincification of boiler fittings, this attack on boiler fittings is really due to excessive alkalinity. As zinc is easily soluble in caustic soda, chlorides in this case merely accentuate the caustic attack, and the real cure is to reduce the alkalinity of the water in the boiler. The installation of carefully controlled continuous blow-down would probably help.

If it would help Mr. Allen at all, I am using at March a liquid scale dissolver, which we have proved not to attack the metal; this is known as "Epheta," and we apply it to the heater *in situ*. Perhaps he already does this, but we have proved it quite satisfactory. This, of course, refers to his last question regarding gas water heaters on the district.

Mr. **R. P. Donnelly** wrote: In Mr. Mortimer's Paper the question of "caustic embrittlement" is discussed. It may be useful to mention that the most recent information on this subject is that, provided a boiler is well riveted and made from good steel, caustic embrittlement is not encountered. If an inhibitor is used, then lignins and certain tannins are now prepared, and are regarded as superior to sodium sulphate of the A.S.M.E. code.

In confirmation of this view I have never yet encountered a case of caustic embrittlement among boilers using waters containing up to 200 grains Na_2CO_3 in the boiler—boiler pressure up to 250 lb. With an average water it would not, of course, be good practice to go above 200 grains Na_2CO_3, as the other salts in the water would then be over concentrated. This, I think, is the explanation of the corrosion of the fusible plug mentioned by Mr. Mortimer. Unless the figure of 900 grains is a misprint it would signify, on an average water, up to 5,000 grains of other solids—about a 7% saline solution. With such concentrations very marked corrosion would be expected.

Apparently where embrittlement does occur it appears at first as leaky boiler seams, and so warning of boiler failure is given. It exists, but it is not a thing to be over-anxious about.

GAS-WORKS PAINTING IN WARTIME

By E. M. POOL,

Chief Technical Adviser (Gas Section), Donald Macpherson & Co., Ltd., Manchester

THE problem of combating corrosion and adequately protecting gas-works plant and buildings by means of painting during the present labour shortage is one which confronts most gas engineers these days. Although certain undertakings have spent large sums of money on maintenance painting during the last few years, some works have done little or no painting since 1939, and at many of these the position is becoming serious. Engineers are suddenly faced with the fact that portions of their plant have reached such a corroded state that drastic treatment and much expense will be necessary to put them right.

Although shortage of labour is general and presents the main difficulty, some works appear to be better off than others in this respect. It is urged that where men are available, protective painting should be undertaken without delay, for it behoves us to take things in time, and do what we can before any steelwork requires completely stripping down to bare metal and the application of three coats of paint to restore it to an adequately protected condition. Moreover, even after the war, priorities and restrictions on all materials and labour will most probably operate for a considerable time. As it is unlikely that undertakings will be able to do all the re-painting they should, straight away, it is necessary to tackle the *essentials* now.

In common with the Gas Industry, paint manufacturers also have their troubles, for most paint ingredients are in short supply. In consequence, wherever paint is used, it is imperative that the labour expended upon its application be utilized to the best advantage. Preparatory cleaning and removal of corrosion should be thorough, and only painting processes employed which will ensure the utmost protection and durability on whatever structures they are applied. It is, therefore, the purpose here to give some indication as to the best painting specifications to adopt and the most suitable types of paint to incorporate therein, under the present conditions.

Painting Programme

When it has been decided to carry out protective painting, a survey of the works should first of all be made, during which a "Schedule of Condition" may be drawn up and a plan of action adopted.

As a guide, a schedule such as the following is suggested:

"*Bad.*"—Extensive areas of steelwork devoid of paint, and rusting. Large patches of loose paint, with corrosion obviously proceeding under the film. Paint generally in a loose state and porous, useless as protection and liable to encourage and assist corrosion. Paint in a spongy condition, saturated with water throughout its thickness down to the metal.

"*Poor.*"—Widespread rusting, in patches as large as 6 in. in diameter. Rust spreading underneath the edges of scaling paint. Remainder of paint probably in need of a further coat to renew its protective ability.

"*Moderate.*"—Occasional corrosion scabs or pits, often along edges of laps and lines of rivets. Remainder of paint fair.

To illustrate "Bad," a crown or outer lift may have suffered more than the rest of the holder, and the engineer will not feel happy about this portion going through another winter without attention.

Upon inspection it must be decided how much of the area under treatment requires stripping of loose paint and cleaning down to the metal. Here it is stressed that it is essential for this preparation work to be thorough. To apply any paint over a hastily and improperly prepared surface wastes time, labour, and materials, and surely leads to future trouble. No loose, cracking, or curling paint should be left; it must be removed with scrapers and wire brushes, particular attention being paid to the edges of all corroded areas. These should be slightly enlarged by scraping and brushing until firm, sound paint is reached, to eradicate any rust which may be creeping under the edges of the paint. Wherever the clean metal is showing, a coat of chromate red lead paint should be applied as soon as possible after the scraping and wire brushing process. If the sheeting has not been painted for some years, the condition of the remaining paint on it will probably be very poor, having lost most of its elasticity and protective properties. It will therefore be advisable, after the chromate red lead has been applied to the stripped portions of the sheeting, to give a good oily intermediate coat, such as sublimed blue lead paint, to the whole of the area before the application of the finishing or protective coat. This will satisfy the porosity of the old paint film and revivify it, thus preventing the finishing coat which is to follow being robbed of much of its oil content—*i.e.*, its durability and wearing properties. This intermediate coat greatly prolongs the life of the whole treatment.

Furthermore, the use of an intermediate coat of blue lead will ensure that three coats of paint are given to all areas where the metal has been laid bare, and that in conformity with correct practice, two of these coats are lead (corrosion inhibiting) paints.

It has been established, after prolonged tests, that three coats on bare metal is the minimum which may be relied upon to give adequate protection.

To give an instance under the heading "Poor," first, all the rust patches should be prepared in the manner previously described, the same careful attention being paid to the edges; then a coat of chromate red lead paint, followed by a coat of blue lead paint, applied to all bare metal areas. Further treatment then depends upon the state of the existing paint. If it is considered that this will afford protection for a further twelve months, the places which have received red lead

and blue lead should be given a coat of finishing protective paint and the job left at that. If, however, it is considered that the remaining paint has gone far enough, a coat of finishing paint should be used all over. In either case, it will undoubtedly pay to adopt the latter course, as this will effectively check excessive deterioration of the old paint and prevent rusting commencing beneath it. To leave a film of finishing paint too many years renders it lifeless and porous, and this condition absorbs a large proportion of the oil content of any future coat of paint.

Cases in the "Moderate" category will usually suffice if, after the corroded spots are thoroughly cleaned up, they are given two "spot" coats, using red lead and blue lead. This, however, is the minimum attention they should receive; the treatment will be greatly improved if a third "spotting" is applied, using finishing paint, or, alternatively, blue lead again.

Types of Paint to Use

Wherever metal has been laid bare by the removal of old, loose paint and rust scale, a basic or "rust inhibiting" priming paint is called for. This is to render the surface of the metal "passive"; in other words, to retard the renewal of corrosion by electro-chemical action. For this important priming coat, chromate red lead paint has been chosen because it possesses these basic and corrosion inhibiting characteristics in greater degree than any other paint. Furthermore, it is of extremely fine particle size, which enables it to penetrate right down into the metal, makes it easier working, provides excellent covering power, and keeps the paint in good suspension in the container, so that it does not settle hard at the bottom. Fine particle size, easy working, and good coverage, all assist in producing a continuous, protective film of paint which will exclude moisture and fume-laden atmosphere from the surface of the metal.

Sublimed blue lead paint has been mentioned as a second coat, either for application all over, or for "spotting" purposes. It possesses the basic property referred to above, and so may be used successfully, either directly on to the metal, or as the next coat immediately over chromate red lead. It also wears remarkably well if employed as a finishing coat. Although no single type of paint can justly claim to fulfil every painting requirement, the present labour difficulty certainly calls for a material which may be relied upon to provide good protection and wearing properties when circumstances will only allow one coat to be applied. Sublimed blue lead meets this need most satisfactorily.

Concerning lead paints generally, it should be remembered that, in painting, as in building, upon the foundation depend strength and durability.

With regard to the choice of a finishing or protective coat, paints made on a "micaceous ore" base are strongly recommended, particularly at the present time. They possess the following qualifications:

(1) Exceptional durability in either rural or chemically-laden industrial atmospheres.

(2) Neutrality of colour from an A.R.P. standpoint.

(3) In reasonably good supply.

Micaceous ore paint ranked very highly in the recent "Derby tests"—carried out at the L.M.S. Railway Works, Derby, under the auspices of the Protective Coatings Sub-Committee of the Corrosion Committee of the Iron and Steel Institute, to assess the relative values of various types of protective coatings during the present shortage of raw materials due to wartime conditions. There is nothing "fancy" about it; the pigment content is chiefly micaceous or spathetic iron ore, an earth product, which is chemically inert and totally unaffected by the most concentrated industrial fumes. Moreover, it provides an excellent base for future re-painting—an important point.

Application

While on the subject of the best materials to use, it may not be out of place if several points are stressed with regard to their application. Before painting, make sure that the old paint already on the holders has properly dried out throughout its film thickness (this applies particularly to the old paint on outer lifts), and that no water or moisture is trapped therein when the new coat of paint is applied. Omission to do this frequently causes early breakdown, as the moisture is drawn out through the new paint film, resulting in its ruin.

After painting give the new coat as long as holder demands will permit to harden off properly. Linseed oil paints oxidize and dry to an impermeable film very similar to linoleum. This, however, takes time, and the longer time allowed, the better, particularly for finishing coats. If the new paint is lowered into the water while it is still hungry for oxygen it is prevented from reaching an adequately "waterproof" state, and is thus rendered liable to attack, and early failure may result. The early stages are the most critical in the life of a paint film from almost every point of view, and the influences to which it is subject during this period will materially affect its durability and behaviour.

There are, of course, instances where it is impossible to leave the outer lift of a holder fully inflated long enough to allow the new paint to dry. If shortage of storage capacity, due to the immobilization of a waterless holder, for instance, renders it necessary to lower the holder within, say, 3-4 hours following the application of the paint, recourse to one of the special rapid hardening paints, similar to those brought out by my Company, is recommended. This type of paint may be used on the outer lift and enables the holder to be used without too much delay, because providing that the old paint is thoroughly dried before painting is commenced, the newly treated sheets may be lowered into the water three hours after the application. The first few immersions should not be of prolonged duration, but as it usually happens that an undertaking short of storage capacity is compelled to raise and lower the holders frequently, there is little risk of the new paint being under water for more than a few hours at a time. The paint referred to contains special rapid hardening and water-resistant oils and is known as "Quicknamel." It has proved of considerable advantage in several instances where it has been impossible to allow the drying time demanded by ordinary oil paint.

If, however, it is impossible to keep the outer lift of a holder fully inflated even for three hours, treatment of this lift, or at least the bottom half thereof, with a non-drying or grease paint is recommended. This type of protective coating gives better results if applied direct to the sheets after the old paint has been removed. Should lack of time or labour not allow this, the non-drying paint may be spread over the old existing paint.

Another point—any red lead priming coat should be applied *as soon as possible* after the cleaning process. As bare steelwork commences to rust immediately upon exposure to the exterior atmosphere, it is inadvisable to prepare large areas of surface before applying any priming paint.

No painting should, of course, be carried out when there is early morning or evening dew on the surface, or before the dampness caused by rain or immersion of the sheeting in tank water has had time to thoroughly dry off. No paint should be applied if there is any frost on the surface.

While it is appreciated that the present time of the year is not ideal for exterior painting, a considerable amount can be carried out with safety if the work is not commenced too early in the morning and does not continue too late in the afternoon—when there is risk of condensation upon the surface.

Buildings and Other Plants

The protective re-painting of offices, workshops, meter and governor houses, and similar buildings, consisting chiefly in the treatment of doors and window-frames (interior and exterior) and walls, ceilings and fittings (interior), calls for a different class of paints from those used on holders, &c.

The priority covering gas-works requirements, except in the case of external and very necessary work, is not sufficiently high to permit the supply of the old pre-war decorative finishes normally used in such cases, but there is available a wartime range of gloss paints and water paints (or distempers) made from less rigidly controlled raw materials (though these are subject to a quota). These products naturally cannot be expected to provide the same high-class appearance associated with pre-war finishes, yet they are soundly constructed and will afford good protection. Recourse to this range may be made whenever need arises.

For the treatment of C.W.G. plant, waste heat boilers, flues, chimneys, and similar equipment which in normal times was usually painted with heat-resisting aluminium paint (no longer available), heat-resisting graphite paint or "micaceous ore" paint is recommended. These will provide excellent protection and withstand moderately high temperatures, and are equally suitable for exterior or interior application.

In dealing with C.W.G. plant and other surfaces which have been subject to heat, it is important to remove all loose or scaling paint prior to the application of a new coat, otherwise the oil content of the new paint soaking into the old, porous surface may cause it to flake and peel in a very short time.

For portions of the plant which have to withstand both heat and external weather conditions, before using the finishing paint it will be found advisable to apply a coat of sharp-drying red lead primer on parts where the old paint has flaked off, to arrest any corrosion which may be forming.

Some of the foregoing may appear somewhat ambitious to undertake during present wartime conditions, but it must be remembered that in the initial inspection of the steelwork only the worst portions would be chosen to receive attention. As the schedule describes, these are all instances where patches of corrosion are showing in greater or less degree. There will doubtless be considerable areas of the surface which, although the paint film may be unbroken and no corrosion be visible thereon, would in normal times be considered ready for re-painting. To-day these will probably have to last a little longer.

It is not an unduly ambitious, but often an essential, programme on which to embark. It is another part of the war effort to preserve steelwork and prevent renewals until such time as labour and materials are once more available in abundance.

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The prices of Coal Tar Products are unchanged.

The Provinces Nov. 29.

The average prices of gas-works products during the week were: Pitch and Crude Tar,* Toluole, naked, North, 90's, 1s. 11d. to 2s. 1d., pure, 2s. 7½d. (controlled by the Control of Toluene No. 3 Order, dated July 14, 1943, operative from July 20, 1943). Naphtha and Xylole controlled by the Coal Tar Naphtha and Xylole Order, 1943, dated May 31 (S. R. & O., 1943, No. 768), operative from June 1. Carbolic acid, 60's, naphthalene, anthracene, creosote oil (hydrogenation), coal tar oils (timber preservation, &c.), and strained anthracene oil controlled by the Coal Tar Products Prices Order, 1943, dated Oct. 20, 1943 (S. R. & O. 1943, No. 1528), operative from Nov. 15, 1943.

* In regard to pitch and crude tar prices we would ask readers to refer to the editorial note on p. 396 of the "JOURNAL" for Sept. 10, 1941.

Scotland Nov. 27.

Trading continues on substantial lines. Refined tar*: Yield to Distillers is 4½d. per gallon *ex* Works, naked. Creosote oil: Timber preserving quality,* 5½d. to 6½d.; hydrogenation oil,* 5⅞d.; low gravity or virgin oil,† 7¼d. to 7½d.; benzol absorbing oil,* 6½d. to 8d. per gallon. Refined cresylic acid* is 3s. 6d. to 4s. 6d. per gallon *ex* Works, naked, according to quality. Crude naphtha†: 6½d. to 7d. per gallon. Solvent naphtha*: Basic prices delivered in bulk, 90/160 grade, 2s. 8d and 90/190 Heavy naphtha, Unrectified, 1s. 10½d.; Rectified, 2s. 3d. per gallon. Pyridine†: 90/160 grade, 13s., and 90/140 grade, 15s. per gallon.

* Price controlled. † Uncontrolled.

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GAS STOCKS AND SHARES

Markets remained idle and dull throughout the week, and on most days the number of markings was the lowest since June. The only outstanding feature was the sharp rise in Brazilian Bonds, although profit-taking later caused a set-back.

The volume of business in Gas stocks and shares continued very small with few price changes, the decreases unfortunately exceeding the increases. Gas Light units reacted a little, so also did Commercial, Imperial Continental, and South Metropolitan ordinaries. It will be seen that a few debenture stocks closed a point or two down. Last week's experience was typical of the month as a whole, during which conditions remained quiet and irregular.

Several additions have been made this month to the Lists below. Guildford 4½% redeemable debenture stock has been added to the Supplementary List and Exeter (10%) original stock (quoted at Bristol) included under Provincial Exchanges, together with the three redeemable stocks of the Liverpool Company and two additional Newcastle debenture stocks.

The following price changes occurred during the week:

OFFICIAL LIST

Associated Gas & Water 4½ p.c. Red. Cum. Pref.	19/9—20/9	+-/6d.
Commercial Ord.	66—69	—1
East Surrey 5 p.c. Deb.	115—120	—3
Gas Light Units	18/3—19/3	—/3d.
Imperial Continental	86—89	—1
Plymouth & Stonehouse	99—104	+2
Portsmouth	122—127	+2
Primitiva Holdings, Ltd., Ord.	11/—13/-	+-/6d.
South Metropolitan Ord.	83—88	—1
Ditto 3 p.c. Deb.	82—86	—1
United Kingdom Ord.	21/—22/—	—/3d.
Wandsworth 4 p.c. Pref.	92—97	+1

SUPPLEMENTARY LIST

Brighton 5 p.c. Deb.	115—120	—2
Slough 5 p.c. Deb.	115—120	—2

Quotations on the London and Provincial Stock Exchanges

OFFICIAL LIST

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Nov. 25
1,767,439	Sept. 6	—	2	Alliance & Dublin Ord. ...	102—112
374 000	June 28	4	4	Do. 4 p.c. Deb.	95—100
583,407	Nov. 8	5	5	Assed. Gas & Water U'd'ts Ord.	21/—22/—
388.938	,,	—	—	Do. Deferred	21/—22/—
500.000	,,	4½	4½	Do. 4½ p.c. Red. Cum. Pref.	19/9—20/9
535,545	,,	4	4	Do. 4 p.c. Red. Cum Pref.	19/6—20/6
341,966	,,	4	4	Do. 4 p.c. Irred. Cum. Pref.	17/6—18/6
561,370	Aug. 16	7	7	Barnet Ord. 7 p.c.	155—160
300,000	Oct. 11	1/9½	1/4½	Bombay, Ltd.	24/—26/—
690,407	Aug. 16	7	7	Bournemouth 7 p.c. max. ...	150—155
362,025	June 15	4	4	Do. 4 p.c. Deb. ...	105—110
659,955	Sept. 6	2½	2½	Brighton, &c., 5 p.c. Con. ...	88—93
855,000	,, 13	6	6	Brit. Gas Light Ord.	110—115
545,000	June 28	5½	5½	Do. 5½ p.c. 'B' Cum. Pref.	110—115
120,000	,, 15	4	4	Do. 4 p.c. Red. Deb.	92—97
10,000	Nov. 6 '33	6	4	Cape Town, Ltd., 4½ p.c. Cu. Pf.	50/—70/—
626,860	July 19	6	6	Cardiff Con. Ord.	117—122
24,500	Nov. 15	7	7	Colombo 7 p.c. Pref.	21/6—23/6
764,169	Sept. 27	-/9.56	-/9.56	Colonial Gas Assn. Ltd. Ord. ..	12/6—17/6
400,000	,,	1/3.298	1/3.298	Do. 8 p.c. Pref. ...	¾—⅞
1,748,090	July 22 '40	2	3	Commercial Ord.	66—69
620,000	June 7	3	3	Do. 3 p.c. Deb.	67—72
286,344	Aug. 23	5	5	Do. 5 p.c. Deb.	108—113
807,560	,, 23	6	6	Croydon sliding scale	121—126
644,590	,,	5	5	Do. max. div.	102—107
620,385	June 28	5	5	Do. 5 p.c. Perp. Deb. ...	120—125
179,500	Feb. 22	5	5	East Surrey 'B,' 5 p.c.	88—93
176,461	June 28	5	5	Do. 5 p.c. Deb. (Irred.)...	115—120
250,000	Nov. 8	4	6	Gas Consolidation Ord. 'B' ...	19/—21/—
250,000	,,	4	4	Do. 4 p.c. Red. Cum. Pref.	18/—20/—
19,107,811	Aug. 9	†1	3	Gas Light & Coke Ord. ...	18/3—19/3a
2,600,000	,,	†1½	3½	Do. 3½ p.c. max.	75—80
4,477,106	,,	4	4	Do. 4 p.c. Con. Pref. ...	95—98
2,993,000	July 12	3½	3½	Do. 3½ p.c. Red. Pref. ...	95—98
8,602,497	May 31	3	3	Do. 3 p.c. Con. Deb. ...	83—86
3,642,770	,,	5	5	Do. 5 p.c. Red. Deb. ...	107—110
3,500,000	,,	4½	4½	Do. 4½ p.c. Red. Deb. ...	106—109
700,000	Sept. 6	3½	3½	Do. 3½ Red. Deb. ...	96—99
5,600,000	May 13 '40	4	8	Imperial Continental Cap. ...	86—89
43,820	July 26	3½	3½	Do. 3½ p.c. Red. Deb. ...	95—100
231,978	Aug. 23	5	5	M.S. Utility 'C' Cons.	95—100
918,657	,,	4	4	4 p.c. Cons. Pref.	90—95
675,000	Nov. 15	‡4	‡4	Montevideo, Ltd.	92—97
300,000	April 27	9	7	Oriental, Ltd.	115—120
368,537	June 15	3½	2½†	Plymouth & Stonehouse 5 p.c.	99—104
621,667	Aug. 16	7½	7½	Portsmouth & Gosport Cons.	122—127
2,381,363	May 17	4†	4†	Primitiva Holdings, Ltd. Ord.	11/—13/-
233,900	June 15	3½	3½	Do. 6½ p.c. Red. Cum. Pref.	101—106
648,999	Sept. 13	1/1½	1/1½	Severn Val. Gas Cor. Ltd. Ord.	21/3—22/3
597,972	,,	4½	4½	Do. 4½ p.c. Cum. Pref. ...	20/—21/—
2,528,714	Aug. 23	7½	7½	South East'n Gas Cn. Ltd. Ord.	21/3—22/3
1,000,000	,,	4½	4½	Do. 4½ p.c. Red. Cum. Pref.	19/9—20/9
1,068,869	,,	4	4	Do 4 p.c. Irred. Cum. Pref.	19/—20/—
6,709,895	Feb. 22	†1	—	South Met. Ord.	83—88
1,135,812	Aug. 16	†6	6	Do. 6 p.c. Irred. Pref. ...	124—129
850,000	,,	†4	4	Do. 4 p.c. Irred. Pref. ...	90—95
1,895,445	June 28	3	3	Do. 3 p.c. Perp. Deb. ...	82—86
1,000,000	July 12	5	5	Do. 5 p.c. Red. Deb. ...	103—108
1,843,795	Aug. 3	4	4	South Suburban Ord. 5 p.c ...	97—102
512,825	,,	5	5	Do. 5 p.c. Perp. Pref. ...	107—112
500,000	,,	4	4	Do. 4 p.c. Perp. Pref. ...	89—94
250,000	,,	3½	3½	Do. 3½ p.c. Red. Pref. ...	90—95
888,587	June 15	3	5	Do. 5 p.c. Perp. Deb. ...	120—125
750,541	Aug. 16	6	5	Southampton Ord.	95—100
350,000	,, 15	5½	5½	Swansea 5½ p.c. Red. Pref. ...	100—105
1,076,495	Aug. 3	5	5	Tottenham & District Ord. ...	108—113
338,555	,,	5	5	Do. 5 p.c. Pref.	106—111
453,380	June 7	4	4	Do. 4 p.c. Perp. Deb. ...	99—104
1,247,505	Nov. 1	4	6	U. Kingdom Gas Cor. Ord. ...	21/—22/—
1,085,952	,, 15	4½	4½	Do. 4½ p.c. 1st Cum. Pref. ...	19/6—21/6
772,709	,,	4	4	Do. 4 p.c. 1st Red. Cum.Pref.	19/—21/—
745,263	June 21	4½	4½	Do. 4½ p.c. 2nd Non.Cum. Pf.	17/—19/—
1,200,000	Sept. 13	3½	3½	Do. 3½ p.c. Red. Deb. ...	95—100
380,606	Aug. 16	6½	6½	Uxbridge, &c., 5 p.c.	118—123
1,371,138	,, 3	6	5	Wandsworth Consolidated ...	108—113
2,525,768	,,	4	4	Do. 4 p.c. Pref.	92—97
1,343,964	June 15	5	5	Do. 5 p.c. Deb.	120—125
383,745	,,	4	4	Do. 4 p.c. Deb.	99—104
558,342	Aug. 9	5	5	Watford & St. Albans Ord. ...	110—115
300,000	June 7	3½	3½	Do. 3½ p.c. Red. Deb. ...	90—95

SUPPLEMENTARY LIST

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Nov. 25
351,685	June 1	5	5	Brighton, &c., 5 p.c. Perp. Deb.	115—120
415,250	,,	4	4	Bristol Gas Co., 4 p.c. New Deb.	97—102
140,205	July 26	7	7	Cambridge, &c., 7 p.c. Cons. 'B'	135—140
295,932	Aug. 16	5	5	Cheltenham, 5 p.c. Cons.Ord....	97—102
42,500	June 15	4	4	Do. 4 p.c. Perp. Deb....	95—100
150,000	Aug. 23	4	4	Croydon Gas, 4 p.c. Pref. (Irr.)	92—97
130,000	June 28	4	4	Do. 4 p.c. Deb. ...	100—105
146,700	Aug. 30	5½	5½	East Surrey, 5½ p.c. Pref. 'A' ...	110—115
53,220	,,	6	6	Do. 6 p.c. Cum. Pref. ...	120—125
...	Aug. 19 '40	6	4	Eastbourne, 'B' 3½ p.c.... ...	62—67
117,425	Feb. 5 '40	8	8	East Wight Cons. 5 p.c. ...	77—82
239,135	Nov. 8	5	5	Gas Consolidation 'A' Ord. (£1)	18/—20/-
25,000	June 21	4½	4½	Guildford 4½ p.c. Red. Deb. ...	100—105
156,600	Aug. 16	5	5	Hampton C't, 5 p.c. Cons. Ord.	95—100
18,000	Dec. 29'41	3½	3½	Malta & Med'n., 7 p.c. 1st Pref.	30—40
10,845	June 30'41	3½	3½	Do. 7½ p.c. 2nd Pref.	30—40
50,000	Aug. 23	£5 4 6	£5 4 6	Mid. South. Util., 'A' Cons. 5 p.c.	105—110
70,380	June 21	5	5	Newport (Mon.), 5 p.c. Deb...	110—115
65,000	Aug. 16	5	5	North Middlesex, 5 p.c. Pref....	104—109
70,000	Sept. 13	5	5	Plymouth & Stone., 5 p.c. Deb.	112—117
76,501	June 21	4	4	Reading, 4 p.c. Perp. Deb. ...	97—102
74,777	Sept. 30	4	4	Romford, 4 p.c. Debs. (Reg.) ...	95—100
21,000	June 15	5	5	Slough, 5 p.c. Perp. Deb. ...	115—120
211,740	,, 28	5	5	Southampton, 5 p.c. Red. Deb.	103—108
363,575	July 1	5	5	Tottenham, 5 p.c. Reg. Red. Mt.	99—102
202,019	Aug. 16	7⅞	7½	Tunbridge Wells, 4 p.c. Scale ...	125—130
135,257	June 15	5	5	Uxbridge &c., 5 p.c. Perp. Deb.	117—122

PROVINCIAL EXCHANGES

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Nov. 19
804,948	Oct. 18	5	5	Bath Cons.	102—105
122,577	Aug. 9	7	5	Blyth 5 p.c. Ord.	114—116
1,667,250	July 19	5	5	Bristol, 5 p.c. max.	115—117
120,420	June 15	4	4	Do. 1st 4 p.c. Deb.	100½—102½
415,250	,,	4	4	Do. 2nd 4 p.c. Deb. ...	100½—102½
328,790	,,	5	5	Do. 5 p.c. Deb.	116—120
157,150	Aug. 3	6½	5	Chester 5 p.c. Ord.	98—102
92,500	June 15	4	4	Do. 4 p.c. Pref.	80—82
36,430	,,	3½	3½	Do. 3½ p.c. Deb.	86—90
41,890	,,	4	4	Do. 4 p.c. Red. Deb. ...	97—99
542,270	Aug. 9	9	6	Derby Cons.	121—126
55,000	June 15	4	4	Do. 4 p.c. Deb.	97—102
40,000	Aug. 9	10½	10½	Exeter 10 p.c.	185—195
10,000	,, 9	10	10	Great Grimsby 'A' Ord. ...	160—170
6,500	,,	10	10	Do. 'B' Ord. ...	160—170
79,000	,,	10	10	Do. 'C' Ord. ...	150—160
732,000	Aug. 23	4	4	Hartlepool G. & W. Cn. & New	91½—92½
2,167,410	,, 16	5½	5	Liverpool 5 p.c. Ord.	111—111½
490,681	June 21	—	3½	Do. 3½ p.c. Red. Stk. ...	90—95
245,500	,,	—	—	Do. 4 p.c. Red. Stk. ...	101—103
306,083	July 15	4	4	Do. 4 p.c. Deb.	100—102
680,000	June 15	—	5	Do. 5 p.c. Red. Stk. ...	105—110
20,000	,, 21	5	5	Long Eaton 5 p.c. Pref. ...	9—11
80,000	,,	5	5	Do. 5 p.c. Deb.	105—110
2,430,267	Aug. 3	5½	5½	Newcastle and Gateshead Con.	23/9—24/3a
682,856	,,	4	4	Do. 4 p.c. Pref.	99—101
776,706	June 28	3½	3½	Do. 3½ p.c. Deb.	96½—97½
250,000	,, 15	3½	3½	Do. 3½ p.c. Red. Deb. ...	99—101
73,186	Nov. 1	4	4	Do. 4 p.c. Red. Deb. ...	99—101
13,200	Sept. 16	8½	7	Pontyp'l Gas & W. 10 p.c. 'A'	11½—12½
13,600	,,	6	5	Do. 7 p.c. 'B'	9½—10½
40,000	,,	5	6	Do. 7 p.c. 'C'	9½—10½
106,280	Aug. 9	10	10	Preston 'A' 10 p.c.	167—169
188,219	,,	7	7	Do. 'B' 7 p.c.	124—129
1,806,339	,, 30	6½	6½	Sheffield Cons.	136—139
95,000	July 5	4	4	Do. 4 p.c. Deb.	98—100
332,351	Sept. 6	6	6	Sunderland 6 p.c. max. ...	113½—115½
192,150	Aug. 9	5	5	Weston-super-Mare Cons. ...	108—110
64,338	July 5	4	4	Do. 4 p.c. Deb.	99—101
33,340	,,	7½	7½	Do. 7½ p.c. Deb.	142—147

a—The quotation is per £1 of Stock. * Ex. div. † For year. ‡ Paid free of income-tax.

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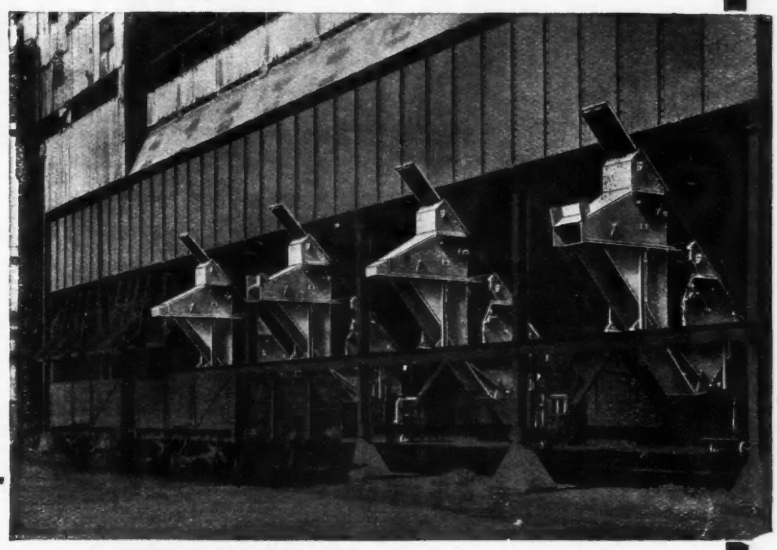

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